5411. (new) The method of claim 5400, wherein producing the mixture comprises producing the mixture in a production well, and wherein at least about 7 heaters are disposed in the formation for each production well.

5412. (new) The method of claim 5400, wherein at least about 20 heat sources are disposed in the formation for each production well.

Response To Office Action Mailed July 26, 2002

A. Pending Claims

Claims 1608-1685 and 5396-5412 are currently pending. Claims 1608-1617, 1619, 1631, 1634, 1639, 1641, 1642, 1644-1656, 1658, 1670, 1673, 1678, 1680, 1681, 1683-1685, 5396, and 5397 have been amended. Claims 5398-5412 are new.

B. Submission of Corrected Formal Drawings

In the Office Action mailed July 26, 2002, the Examiner indicated approval of the proposed drawing corrections filed on February 26, 2002 [mailed on February 21, 2002]. Applicant herewith submits the corrected formal drawings approved by the Examiner (nine sheets, including FIGS. 23a, 23b, 32, 56, 57, 67, 68, 72, 73, 76, 81a and 97).

C. Provisional Double Patenting Rejection

The Examiner provisionally rejected claims 1608-1685 and 5396-5397 under the judicially created doctrine of obviousness-type double patenting as being unpatentable over copending U.S. Patent Applications:

09/841,000; 09/841,060; 09/841,061; 09/841,127; 09/841,128; 09/841,129; 09/841,130; 09/841,131; 09/841,170; 09/841,193; 09/841,194; 09/841,195; 09/841,238; 09/841,239;

09/841,240; 09/841,283; 09/841,284; 09/841,285; 09/841,286; 09/841,287; 09/841,288; 09/841,289; 09/841,290; 09/841,291; 09/841,292; 09/841,293; 09/841,294; 09/841,295; 09/841,296; 09/841,297; 09/841,298; 09/841,299; 09/841,300; 09/841,302; 09/841,303; 09/841,304; 09/841,305; 09/841,306; 09/841,307; 09/841,308; 09/841,309; 09/841,310; 09/841,311; 09/841,312; 09/841,429; 09/841,430; 09/841,431; 09/841,432; 09/841,433; 09/841,434; 09/841,435; 09/841,436; 09/841,437; 09/841,438; 09/841,439; 09/841,440; 09/841,441; 09/841,442; 09/841,443; 09/841,444; 09/841,445; 09/841,446; 09/841,447; 09/841,448; 09/841,449; 09/841,488; 09/841,489; 09/841,490; 09/841,491; 09/841,492; 09/841,493; 09/841,494; 09/841,495; 09/841,496; 09/841,497; 09/841,498; 09/841,499; 09/841,500; 09/841,501; 09/841,502; 09/841,632; 09/841,633; 09/841,634; 09/841,635; 09/841,636; 09/841,637; 09/841,638; and 09/841,639.

Applicant respectfully traverses the provisional double patenting rejection. Applicant respectfully submits that the omnibus nature of this rejection does not provide Applicant with sufficient detail in which to address such rejection. Applicant also respectfully submits that the rejection is also inconsistent with certain restrictions issued in the above-referenced cases. Applicant respectfully requests reconsideration.

Pursuant to the discussion in an Examiner interview on August 19, 2002, for the convenience of the Examiner, Applicant will forward copies of allowed claims for the above-referenced cases to the Examiner. Applicant understands that the Examiner will review the allowed claims for the above-referenced cases and then reconsider the double patenting rejection in view of such allowed claims.

D. The Claims Are Not Indefinite Pursuant To 35 U.S.C. § 112, Second Paragraph

Claims 1608-1685 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Applicant respectfully disagrees with these rejections.

Claims 1644 and 1683 recite, in part "wherein producing the mixture comprises producing the mixture in a production well, and wherein at least about 7 heaters are disposed in

the formation for each production well." The Examiner states "The modified 'about' is not normally used in reference to an integer count (i.e., a number of sources); thus it is unclear what the scope of the claim is."

That claim language, including terms of degree, may not be precise, does not automatically render the claim indefinite under 35 U.S.C. 112, second paragraph. *Seattle Box Co.,. v. Industrial Crating & Packing, Inc.,* 731 F.2d 818, 221 U.S.P.Q. 568 (Fed. Cir. 1984).

The specification states on page 72, lines 24-27, "Providing more heat sources wells per unit area will allow faster heating of the selected portion and thus hastening the onset of production, however more heat sources will generally cost more money to install. An appropriate ratio of heat sources to production wells may also include ratios greater than about 5:1, and ratios greater than about 7:1." Applicant submits that the specification provides support and clarity for claims 1644 and 1683. Applicant requests removal of the rejection of claims 1644 and 1683.

The Examiner states: "While applicant may be his or her own lexicographer, a term in a claim may not be given a meaning repugnant to the usual meaning of the that term. ... Applicant's vague definition of "hydrocarbon" is much broader than the accepted meaning of the term and this makes it impossible for one of ordinary skill in the art to ascertain the scope of the claims which include the term "hydrocarbon". Applicant respectfully disagrees.

Applicant respectfully submits that Applicant has used an accepted meaning of the term "hydrocarbon" as defined by one of ordinary skill in the art. Support for this definition can be found in references within and associated with the art of the petroleum industry. For example, a reference within the art gives the following definition: "**Hydrocarbons**: molecules formed primarily by carbon and hydrogen atoms" (Hyne, N. J. *Geology for Petroleum Exploration, Drilling, and Production*, 1984, McGraw-Hill Book Company, pg. 264). The Specification (page 38, paragraph beginning on line 14) has been amended for clarification. Applicant therefore respectfully requests removal of the rejection of Applicant's definition of the term

"hydrocarbon."

The Examiner states "Claims 1617, 1646 call for the heating energy to be equal to or less than Pwr. Pwr is defined using an ideal equation for heating. Since this equation fails to take into account the endothermic nature of pyrolysis reactions, and heat loss to adjacent formations; it is not clear how the heating energy can be equal to or less than Pwr." Applicant respectfully disagrees with this rejection, however, to expedite the case Applicant has amended claims 1617 and 1646 for clarification. Applicant respectfully submits the amendments to these claims do not substantively change the scope of the claims.

The Examiner states "Claims 1631, 1670 are unclear regarding 'non-condensable component'. It is noted that the specification provides a definition for 'non-condensable hydrocarbon'; however it is not clear whether this definition applies to this component." Applicant respectfully disagrees.

Support for "non-condensable component" is found in Applicant's specification at page 141, lines 6-14. Applicant submits that the specification provides support for claims 1631 and 1670. Applicant respectfully disagrees with this rejection, however, to expedite the case Applicant has amended claims 1631 and 1670 for clarification. Applicant respectfully submits the amendments to these claims do not substantively change the scope of the claims.

The Examiner states "Claims 1642, 1681 are unclear regarding 'substantially uniformly increasing a permeability'. Does this mean 'increasing a permeability to a substantially uniform value' or 'increasing a permeability by a substantially uniform amount'?" Applicant has amended claims 1642 and 1681 for clarification. Applicant respectfully requests removal of the rejection of claims 1642 and 1681.

The Examiner states "Claims 1610, 1649 are unclear regarding "a pyrolysis temperature range". This is unclear because it does not specify the range."

A pyrolysis temperature range is defined in the specification, and support can be found at least in the specification, on page 46, lines 9-16. Applicant submits that the specification provides support for claims 1610 and 1649. Applicant has amended claims 1610 and 1649 for clarification. Applicant requests removal of the rejection of claims 1610 and 1649.

The Examiner states "Claims 1616, 1645 are unclear regarding 'during pyrolysis'. A step of pyrolysis has not been positively claimed, thus the scope of this claim is unclear."

Applicant notes that claim 1645 does not include the feature "during pyrolysis." Applicant respectfully disagrees with the rejection of claims 1616 and 1645, however, to expedite the case Applicant has amended claim 1616 for clarification. Applicant has amended claim 1655 for clarification in a similar manner. Applicant requests removal of the rejection of claims 1616 and 1645. Applicant respectfully submits the amendments to claims 1616 and 1655 do not substantively change the scope of the claims.

The Examiner states "Claims 1631, 1670 call for the hydrogen to be between 10% and 80% of the non-condensable component by volume. The claim does not specify any other conditions such as pressure or temperature. It is noted that many such processes produce a mixture at high pressure. Although gases behave ideally near atmospheric pressure; the product gases of the claimed process deviate significantly from ideal gas law at high pressures. Furthermore, applicant's definition of 'condensable' uses a reference of 25°C; although chemists usually refer to gas measurements at STP. There are some products of this process which condense between 25°C and STP. Such condensation would affect the relative volumes. Without any benchmark temperature and pressure, it is impossible to ascertain the scope of the claim with precision." Applicant respectfully disagrees with this rejection, however, to expedite the case, Applicant has amended claims 1631 and 1670 for clarification. Applicant respectfully submits the amendments to these claims do not substantively change the scope of the claims.

Applicant respectfully requests removal of the rejections of claims 1608-1685.

E. The Claims Are Not Anticipated By Tsai Pursuant To 35 U.S.C. § 102(b)

The Examiner rejected claims 1608, 1610, 1613, 1614, 1618, 1634, 1641-1643, 1647, 1649, 1652, 1653, 1657, 1673, 1680-1682 under 35 U.S.C. 102(b) as being anticipated by U.S. Patent No. 4,299,285 to Tsai et al. (hereinafter "Tsai"). Applicant respectfully disagrees with these rejections.

The standard for "anticipation" is one of fairly strict identity. To anticipate a claim of a patent, a single prior source must contain all the claimed essential elements. *Hybritech, Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 231 U.S.P.Q.81, 91 (Fed. Cir. 1986); *In re Donahue*, 766 F.2d 531,226 U.S.P.Q. 619,621 (Fed. Cir. 1985).

Amended claim 1608 describes a combination of features including: "providing heat from one or more heaters to at least a portion of the formation; allowing the heat to transfer from one or more of the heaters to a part of the formation." Applicant submits that support for the amendments can be found at least in the specification on page 40, lines 1-3: "A heat source may also include a heater that may be configured to provide heat to a zone proximate to and/or surrounding a heating location such as a heater well." In addition, "A "heater" is generally defined as any system configured to generate heat in a well or a near wellbore region." (Specification, page 40, lines 6-8).

Tsai discloses:

> Air is heated to a temperature of about 250° C. and is injected into the injection well at a pressure of approximately 500 psi (35.2 kg/cm^2) and at a rate of about 300 ft^3/min (8.5 m^3/min) (standardized to one atmosphere and 15.6° C.). Injection is continued at this rate for five days. Combustion air at ambient temperature is now injected into the injection hole at a pressure of 50 psi (3.51 kg/cm^2) and at a rate of 1,500 ft^3/min (42.5 m^3/min) (standardized to one atmosphere and 15.6° C.), and a fire is ignited in the coal at the bottom of the injection well. After the underground combustion stabilizes, a combustible product gas is obtained at the production well. (Tsai, col. 7, line 62 to col. 8, line 17).

Tsai does not appear to teach or suggest at least the feature of heating at least a portion of a formation with one or more heaters and allowing heat to transfer from the portion of the formation to a part of the formation, in combination with the other features of the claim. Applicant requests removal of the anticipation rejection of claim 1608 and the claims dependent thereon.

If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988). Applicant submits that many of the claims dependent on claim 1608 are separately patentable.

For example, claim 1610 recites, in part "further comprising maintaining a temperature within the part of the formation within a pyrolysis temperature range of about 270 °C to about 400 °C." At least this feature of claim 1610, in combination with the other features of the claim, does not appear to be taught or suggested by the cited art.

Claim 1613 recites, in part "wherein at least one of the one or more heaters comprises a flameless distributed combustor." At least this feature of claim 1613, in combination with the other features of the claim, does not appear to be taught or suggested by the cited art.

Tsai states:

> Heretofore, when the link has been prepared in a non-swelling coal such as a sub-bituminous coal, the oxidizing gas is injected into the injection hole at an appropriate rate and the fire is started in the coal bed at the injection well. This causes a series of reactions and processes to occur simultaneously including volatilization, pyrolysis, oxidation, reduction, and the like, with the result that a combustible product gas is delivered at the production well. However, when a swelling coal, such as a medium-volatile bituminous coal, is ignited, the coal in the link proximate to the flame heats up above its softening temperature and expands until the linkage is eventually plugged whereupon the gas flow stops and the fire extinguishes. (Tsai, column 2, lines 30-43).

Tsai appears to teach or suggest providing an oxidizing gas to the formation and starting a

fire in the coal formation. Tsai does not appear to teach, suggest, or provide motivation for a flameless distributed combustor, in combination with the other features of the claim.

Claim 1614 recites, in part "wherein at least one of the one or more heaters comprises a natural distributed combustor." At least this feature of claim 1614, in combination with the other features of the claim, does not appear to be taught or suggested by the cited art.

Claim 1618 recites, in part "wherein allowing the heat to transfer comprises transferring heat substantially by conduction." At least this feature of claim 1618, in combination with the other features of the claim, does not appear to be taught or suggested by the cited art.

The Examiner states:

> With regards to claim 1618; the Tsai reference does not explicitly teach the transferring by conduction; however this is inherent in a solid substance such as coal. Even though the bulk of the heating in the Tsai method may be done by convection; it is apparent that some unfractured coal must remain, and thus the allowing heat to transfer comprises transferring heat substantially by conduction (that is, substantially within the unfractured portions).

Applicant respectfully disagrees. Tsai states:

> This link or channel between wells can be naturally occurring permeability in the coal seam involving cracks, fissures and the like. But since naturally occurring paths of suitable gas flow capacity are rare, it is generally necessary by some suitable means to significantly enhance a naturally occurring path or it may be necessary to produce an artificial path for high volume, low pressure gas flow between the injection and production wells. One solution involves the fracturing of the coal bed by injecting under substantial pressure an aqueous mixture containing suitable entrained particles as propping agents to open up fracture planes and channels in which the particles settle out to prop the fractures open when the pressure is released. Another method involves the directional drilling of one or more holes through the coal bed, generally along the bottom portion of the bed, between the injection and production holes. Other linking methods or combinations of linking methods can be used to obtain the linkage between the wells. (Tsai, col. 2, lines 9-29).

Thus, Tsai does not appear to teach or suggest transferring heat substantially by conduction.

Claim 1634 recites, in part "further comprising controlling a pressure within at least a majority of the part of the formation, wherein the controlled pressure is at least about 2.0 bar absolute." At least this feature of claim 1634, in combination with the other features of the claim, does not appear to be taught or suggested by the cited art.

Amended claim 1641 describes a combination of features, including "wherein allowing the heat to transfer comprises increasing a permeability of a majority of the part of the formation to greater than about 100 millidarcy." Amended claim 1642 describes a combination of features including: "wherein allowing the heat to transfer comprises increasing a permeability of a majority of the part of the formation such that the permeability of the majority of the part of the formation is substantially uniform." At least these features of claims 1641 and 1642, in combination with the other features of the claims, do not appear to be taught or suggested by the cited art.

The Examiner states "With regards to claims 1641 and 1642; the Tsai reference teaches the permeability greater than about 100 md in table 1. The uniform increase in permeability is inherent." Applicant respectfully disagrees.

That a certain characteristic *may* be present in the prior art does not establish the inherency of that result or characteristic. *In re Rijckaert*, 9 F.3d 1531, 1534, 28 U.S.P.Q.2d 1955, 1957 (Fed. Cir. 1993). "In relying upon the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic *necessarily* flows from the teachings of the applied prior art." *Ex parte Levy*, 17 U.S.P.Q.2d 1461, 1464 (Bd. Pat. App. & Inter. 1990) [Emphasis in original].

Tsai states: "A series of core samples from this coal were tested to determine the effect on the coal's properties of hot air treatment at different temperatures and for different periods of

time.... The data and analyses are set out in Table I" (Tsai, col. 6, lines 54-59). Permeabilities recorded in Table I are for core samples only. Applicant submits that Tsai does not appear to teach or suggest at least the feature of increasing the permeability of at least a majority of the part of the formation to greater than 100 millidarcy, in combination with the other features of the claim.

Tsai states: "The initial permeability of the core was 2.0, after two days it was 27.5, after three days is was 77.2 and after four days it was 107 as reported in Table I" (Tsai, col. 7, lines 11-14). In addition, Table I of Tsai discloses a permeability of 107 md for Ex. 6 and a permeability of 148 md for Ex. 7, in which the axis of the core was perpendicular to the bedding plane. Applicant submits that at least the feature of "wherein allowing the heat to transfer comprises increasing a permeability of a majority of the part of the formation such that the permeability of the majority of the part of the formation is substantially uniform," in combination with the other features of claim 1642, does not appear to be taught, suggested by, or inherent to Tsai.

Claim 1643 recites, in part "further comprising controlling the heat to yield greater than about 60 % by weight of condensable hydrocarbons, as measured by Fischer Assay." At least this feature of claim 1643, in combination with the other features of the claim, does not appear to be taught or suggested by the cited art.

Amended independent claim 1647 describes a combination of features including: "providing heat from one or more heaters to at least a portion of the formation; allowing the heat to transfer from one or more heaters to a part of the formation." Applicant submits that support for the amendment can be found at least in the specification on page 40, lines 1-3: "A heat source may also include a heater that may be configured to provide heat to a zone proximate to and/or surrounding a heating location such as a heater well." At least the feature of providing heat from one or more heaters to a formation and allowing heat to transfer from one or more heaters to a part of the formation, in combination with the other features of the claim, does not

appear to be taught or suggested by Tsai. Applicant requests removal of the anticipation rejection of claim 1647 and the claims dependent thereon.

In addition, Applicant respectfully disagrees that many of the claims rejected by the Examiner are anticipated or obvious in light of Tsai. Applicant submits that many of the dependent claims rejected by the Examiner are independently patentable.

Claim 1649 recites, in part "further comprising maintaining a temperature within the part of the formation within a pyrolysis temperature range of about 270 °C to about 400 °C." At least this feature of claim 1649, in combination with the other features of the claim, does not appear to be taught or suggested by the cited art.

Claim 1652 recites, in part "wherein at least one of the one or more heaters comprises a flameless distributed combustor." At least this feature of claim 1652, in combination with the other features of the claim, does not appear to be taught or suggested by the cited art.

Claim 1653 recites, in part "wherein at least one of the one or more heaters comprises a natural distributed combustor." At least this feature of claim 1653, in combination with the other features of the claim, does not appear to be taught or suggested by the cited art.

Claim 1657 recites, in part "wherein allowing the heat to transfer comprises transferring heat substantially by conduction." At least this feature of claim 1657, in combination with the other features of the claim, does not appear to be taught or suggested by the cited art.

Claim 1673 recites, in part "further comprising controlling a pressure within at least a majority of the part of the formation, wherein the controlled pressure is at least about 2.0 bar absolute." At least this feature of claim 1673, in combination with the other features of the claim, does not appear to be taught or suggested by the cited art.

Claim 1680 recites, in part "wherein allowing the heat to transfer comprises increasing a

permeability of a majority of the part of the formation to greater than about 100 millidarcy." Claim 1681 recites, in part "wherein allowing the heat to transfer comprises increasing a permeability of a majority of the part of the formation such that the permeability of the majority of the part of the formation is substantially uniform." At least these features of claims 1680 and 1681, in combination with the other features of the claims, do not appear to be taught, suggested by, or inherent to the cited art.

Claim 1682 recites, in part "further comprising controlling the heat to yield greater than about 60 % by weight of condensable hydrocarbons, as measured by Fischer Assay." At least this feature of claim 1682, in combination with the other features of the claim, does not appear to be taught or suggested by the cited art.

F. The Claims Are Not Obvious Over Tsai Pursuant To 35 U.S.C. § 103(a)

The Examiner rejected claims 1609, 1611, 1612, 1619-1631, 1635, 1636, 1648, 1650, 1651, 1658-1670, 1674, and 1675 under 35 U.S.C. 103(a) as obvious over Tsai. Applicant respectfully disagrees with these rejections.

In order to reject a claim as obvious, the Examiner has the burden of establishing a *prima facie* case of obviousness. *In re Warner et al.*, 379 F.2d 1011, 154 U.S.P.Q. 173, 177-178 (C.C.P.A. 1967). To establish a *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 U.S.P.Q. 580 (C.C.P.A. 1974), MPEP § 2143.03.

The Examiner states: "With regards to claims 1609 and 1648; the Tsai reference fails to explicitly teach the superposition of heat sources. It is apparent that one of ordinary skill in the art would know that the heat sources should be spaced to substantially heat the entire formation." Applicant respectfully disagrees.

Amended claims 1609 and 1648 recite, in part "wherein the one or more heaters comprise at least two heaters, and wherein controlled superposition of heat from at least two heaters pyrolyzes at least some hydrocarbons within the part of the formation." At least these features of claims 1609 and 1648, in combination with the other features of the claims, do not appear to be taught or suggested by the cited art.

Claims 1611 and 1650 recite, in part "wherein at least one of the one or more heaters comprises an electrical heater." At least these features of claims 1611 and 1650, in combination with the other features of the claims, do not appear to be taught or suggested by the cited art.

Claims 1612 and 1651 recite, in part "wherein at least one of the one or more heaters comprises a surface burner." At least these features of claims 1612 and 1651, in combination with the other features of the claims, do not appear to be taught or suggested by the cited art.

The Examiner states:

> With regards to claims 1619 and 1658; the Tsai reference does not teach the thermal conductiviy [*sic*]; however, it would have been further obvious to one of ordinary skill in the art at the time of the invention to have practiced the Tsai method in a coal seam having a thermal conductivity of greater than about 0.5 W/(m°C) as called for in claims 1619 and 1658; such a formation would be a desirable choice because it would heat more uniformly.

Applicant respectfully disagrees.

Claims 1619 and 1658 recites, in part "wherein providing heat from one or more of the heaters comprises heating the part of the formation such that a thermal conductivity of at least a portion of the part of the formation is greater than about 0.5 W/(m °C)." Applicant submits that at least this feature, in combination with the other features of the claims, does not appear to be taught or suggested by the cited art.

The totality of the prior art must be considered, and proceeding contrary to accepted

wisdom in the art is evidence of nonobviousness. *In re Hedges*, 783 F.2d 1038, 228 USPQ 685 (Fed. Cir. 1986), MPEP § 2145.

Applicant submits that providing heat from one or more heaters such that a thermal conductivity of a portion of a formation is greater than about 0.5 W/(m °C) is unexpected based on literature in the art. For example, Applicant's specification states:

> Certain embodiments described herein will in many instances be able to economically treat formations that were previously believed to be uneconomical. Such treatment will be possible because of the surprising increases in thermal conductivity and thermal diffusivity that can be achieved with such embodiments. These surprising results are illustrated by the fact that prior literature indicated that certain hydrocarbon containing formations, such as coal, exhibited relatively low values for thermal conductivity and thermal diffusivity when heated. For example, in government report No. 8364 by J. M. Singer and R. P. Tye entitled "Thermal, Mechanical, and Physical Properties of Selected Bituminous Coals and Cokes," U.S. Department of the Interior, Bureau of Mines (1979), the authors report the thermal conductivity and thermal diffusivity for four bituminous coals. This government report includes graphs of thermal conductivity and diffusivity that show relatively low values up to about 400 °C (e.g., thermal conductivity is about 0.2 W/(m °C) or below, and thermal diffusivity is below about 1.7×10^{-3} cm^2/s). This government report states that "coals and cokes are excellent thermal insulators."
>
> In contrast, in certain embodiments described herein hydrocarbon containing resources (e.g., coal) may be treated such that the thermal conductivity and thermal diffusivity are significantly higher (e.g., thermal conductivity at or above about 0.5 W/(m °C) and thermal diffusivity at or above 4.1×10^{-3} cm^2/s) than would be expected based on previous literature such as government report No. 8364. If treated as described in certain embodiments herein, coal does not act as "an excellent thermal insulator." Instead, heat can and does transfer and/or diffuse into the formation at significantly higher (and better) rates than would be expected according to the literature, thereby significantly enhancing economic viability of treating the formation.
>
> (Specification, page 150, line 18 to page 151, line 10).

Thus, Applicant submits that providing heat from one or more heaters heating a portion of the formation such that a thermal conductivity of at least a part of the formation is greater than about 0.5 W/(m °C) is not an obvious matter of choice. Applicant respectfully submits that the Examiner's rejection of the features of claims 1619 and 1658, in combination with the features of

independent claims 1608 and 1647, respectively, as obvious may rely upon personal knowledge of the Examiner and therefore Applicant believes MPEP 2144.03 will apply. Pursuant to MPEP 2144.03, Applicant respectfully requests the Examiner to provide support for his assertion either by an affidavit or by references brought to the Applicant's attention. Otherwise, Applicant requests this rejection be removed. *See, e.g.,* MPEP 2143.01.

The Examiner states:

> With regards to claims 1620-1631, 1635, 1636, 1658-1670, 1674, and 1675; the nature of hydrocarbons produced from such heating is highly variable, and dependent upon many factors, not least of which is the characteristics of the coal. The components of the produced mixture are deemed to be the results of design variables, including coal characteristics and temperature.

Applicant respectfully disagrees.

Applicant submits that the product mixtures recited in claims 1620-1631, 1635, 1636, 1658-1670, 1674, and 1675 would not be producible by carrying out the in situ combustion process of Tsai. The product mixtures recited in claims 1620-1631, 1635, 1636, 1658-1670, 1674, and 1675 may be produced by controlling and/or modifying formation conditions during treatment to produce the selected results recited in the claims.

G. The Claims Are Not Obvious Over Tsai In View of Elkins Pursuant To 35 U.S.C. § 103(a)

The Examiner rejected claims 1615 and 1654 under 35 U.S.C. 103(a) as obvious over Tsai in view of U.S. Patent No. 2,734,579 to Elkins (hereinafter "Elkins"). Applicant respectfully disagrees with these rejections.

The Examiner states:

> It would have been obvious to one of ordinary skill in the art at the time of the invention to have further modified the Tsai process to have included the temperature is controlled as a function of the pressure or the pressure is controlled as a function of the temperature as called for in claims 1615, 1654 and as taught by Elkins, in order to prevent overheating.

Claims 1615 and 1654 describe a combination of features including "controlling a pressure and a temperature within at least a majority of the part of the formation, wherein the pressure is controlled as a function of temperature, or the temperature is controlled as a function of pressure." At least these features of claims 1615 and 1654, in combination with the other features of the claims, do not appear to be taught or suggested by the cited art.

If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious. *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1959), MPEP § 2143.01.

Tsai states:

> The pretreatment and conditioning of the swelling coal before the in situ combustion and gasification procedure is initiated involves the injection of heated air into the injection hole at sufficient pressure to fracture the coal, and the injection of the heated air through the fracture to the production hole without combustion of the coal. The temperature of this heated air should be at least about 100° C. and preferably at least about 150° C. in order to provide an effective pretreatment and conditioning as evidenced by an increased permeability and porosity and a reduced swellability of the coal proximate to the linkage. Since the injection of the heated air should itself not cause the coal to swell, the maximum temperature of the injected air can be up to but not the same as the temperature at which the coal begins to soften, i.e., the softening temperature of the coal. This softening temperature is a property specific to each particular coal (for the determination of the softening temperature of a coal see pages 152-155 of Chemistry of Coal Utilization, Supplementary Volume, 1963, edited by H. H. Lowry). In general, we prefer that the temperature of the heated air be a maximum of about 350° C. and most prefer that the maximum temperature be about 300° C. The range of about 150° C. to about 300° C. is a particularly suitable operating range.

(Tsai, column 3, lines 21-45).

Elkins states:

> It is important to control the temperature within the reaction zone. I have found that the minimum temperature of this zone at which combustion normally can be maintained is of the order of approximately 400° F. It is desirable to maintain the temperature higher than this value up to temperatures from 800° F. to 1000° F. When the temperature rises substantially higher than these values, roughly above 1,200° F., combustion takes place too rapidly, the recoverable cracked products are minimized, the liquefaction occurs considerably ahead of the combustion zone, and, in general, the loss of valuable petroleum products in the combustion itself will become sufficiently great to make the process a good deal less economical. Control of the temperature within the reaction zone can be maintained in several ways. The increase in volume of oxygen-containing gas by application of higher injection gas pressure will increase this temperature. The higher temperature is maintained primarily by the fact that the time available for the loss of sensible heat to the formations adjacent and downstream from the combustion zone is minimized. In addition, the higher rate of injection and the increased supply of oxygen at the reaction zone by virtue of the higher pressures consumes additional oil in combustion above that required at lower rates and thereby generates more heat. To keep the temperature from becoming too high, it is possible to dilute the air with inert gas, for example, by separating the inter gaseous products of combustion (principally oxides of nitrogen and carbon) from the produced hydrocarbons, and introducing it into the injection stream. This slows down the rate of heat generated and provides additional time for sensible heat loss to adjacent formation as well as to the formation itself in front beyond the combustion zone. Decreasing the injection gas pressure also decreases the combustion zone temperature.
> (Elkins, column 3, lines 13-46).

Tsai appears to teach or suggest the injection of heated air at sufficient pressure to fracture coal, wherein the heated air is at a temperature below the softening point of coal, preferably between about 150° C to about 300° C. Elkins appears to teach or suggest the injection of air to maintain combustion within a formation and a temperature between approximately 400° F and 1000° F. Elkins further appears to teach or suggest decreasing the injection gas pressure to decreases the combustion zone temperature when the temperature rises above 1200° F. Applicant submits that combination of the prior art would change the principle of operation of the prior art invention being modified.

Applicant requests removal of the obviousness rejection of claims 1615 and 1654.

H. The Claims Are Not Obvious Over Tsai In View of Kasevich Pursuant To 35 U.S.C. § 103(a)

The Examiner rejected claims 1616, 1617, 1655, and 1656 under 35 U.S.C. 103(a) as obvious over U.S. Patent No. 4,299,285 to Tsai et al. in view of U.S. Patent No. 4,457,365 to Kasevich et al. (hereinafter "Kasevich"). Applicant respectfully disagrees with these rejections.

The Examiner states:

> It would have been obvious to one of ordinary skill in the art at the time of the invention to have further modified the Tsai method to have included heating at a rate of less than about 10°C per day as called for in claims 1617, 1656 in order to achieve more uniform heating. ... It would have been further obvious to one of ordinary skill in the art at the time of the invention to have further modified the Tsai method to have included heating at a rate of less than about 1°C/day as called for in claims 1616, 1655; in order to achieve more uniform heating.

Applicant respectfully disagrees.

Claims 1616 and 1655 describe a combination of features including: "controlling the heat such that an average heating rate of the part of the formation is less than about 1 °C per day during pyrolysis." At least these features of claims 1616 and 1655, in combination with the other features of the claims, do not appear to be taught or suggested by the cited art.

Claims 1617 and 1656 describe a combination of features including: "heating a selected volume (V) of the coal formation from one or more of the heaters, wherein the formation has an average heat capacity (C_v), and wherein the heating pyrolyzes at least some hydrocarbons within the selected volume of the formation; and wherein heating energy/day (Pwr) provided to the selected volume is equal to or less than $h*V*C_v*\rho_B$, wherein ρ_B is formation bulk density, and

wherein an average heating rate (*h*) of the selected volume is about 10 °C/day." At least these features of claims 1617 and 1656, in combination with the other features of the claims, do not appear to be taught or suggested by the cited art.

Tsai states:

> Air is heated to a temperature of about 250° C. and is injected into the injection well at a pressure of approximately 500 psi (35.2 kg/cm^2) and at a rate of about 300 ft^3 /min (8.5 m^3/min) (standardized to one atmosphere and 15.6° C.). Injection is continued at this rate for five days. Combustion air at ambient temperature is now injected into the injection hole at a pressure of 50 psi (3.51 kg/cm^2) and at a rate of 1,500 ft^3/min (42.5 m^3 /min) (standardized to one atmosphere and 15.6° C.), and a fire is ignited in the coal at the bottom of the injection well. After the underground combustion stabilizes, a combustible product gas is obtained at the production well. In situ combustion and gasification continues without plugging until the coal is exhausted in the zone between the wells.
> (Tsai, column 7, line 62 through column 8, line 19).

Kasevich states:

> The process and apparatus for extracting the products of kerogen in situ from an oil shale body by supplying energy selectively to the kerogen by high frequency electric fields in the frequency range between 100 kilohertz and 1000 megahertz at an intensity which heats the kerogen to a temperature range between 250° C. and 500° C. to allow pyrolysis of the kerogen prior to substantial heat transfer to the surrounding mineral portions of the oil shale. A plurality of groups of spaced radiators produce the electric fields for heating the kerogen. A dipole radiator in the subsurface formation is supplied with electromagnetic energy through a transmission line from an energy generator on the surface.
> (Kasevich, abstract).

Kasevich further states:

> In dry oil shale, the conductivity continues to be reduced, as shown by the curve portions 108, reaching a minimum approaching, for example, 10^{-4} mhos per meter at a temperature around 250° C. as shown by curve 112. In this region the major portion of the power is absorbed by the kerogen as shown by curve 118,

> which assumes sufficiently rapid rise in temperature that no pyrolysis has yet taken place and the conductivity of the inorganic or mineral portion of the oil shale approaches 10^{-5} mhos per meter as shown by curve 116.
>
> As shown by the portions of the formation conductivity curves 114, 120, 122, and 124, different radiation rates produce different energy absorption increases with temperature above 250° C. due partly to conversion of the kerogen to higher conductivity products.
> (Kasevich, column 7, line 66 through column 8, line 13).

Tsai appears to teach or suggest igniting a fire in the coal at the bottom of the injection well and waiting for the fire to stabilize. Tsai does not appear to teach, suggest, or provide motivation for controlling the rate of heating. Kasevich appears to teach or suggest heating a formation by providing energy in the form of electric fields, wherein rate of heating is determined by the different inherent conductivities of kerogen and kerogen products. Applicant submits that combination of the prior art would change the principle of operation of the prior art invention being modified.

Applicant requests removal of the obviousness rejection of claims 1616, 1617, 1655, and 1656.

I. The Claims Are Not Obvious Over Tsai In View of Stoddard Pursuant To 35 U.S.C. § 103(a)

The Examiner rejected claims 1632, 1633, 1671, and 1672 under 35 U.S.C. 103(a) as obvious over Tsai in view of U.S. Patent No. 4,463,807 to Stoddard et al. (hereinafter "Stoddard"). Applicant respectfully disagrees with these rejections.

Claims 1632 and 1671 describe combinations of features including: "wherein the produced mixture comprises ammonia, and wherein greater than about 0.05% by weight of the produced mixture is ammonia."

Stoddard discloses: "A seal against water incursion serves two purposes: water is

excluded from the georeactor and the processes underway, and water soluble products of reactions (phenols, ammonia and the like) are excluded from the aquifer" (Stoddard, col. 3, lines 28-31).

Applicant submits that Stoddard, in combination with Tsai, does not appear to teach or suggest a produced mixture with an ammonia content of greater than 0.05%. At least the above quoted features of claims 1632 and 1671, in combination with the other features of the claims, do not appear to be taught or suggested by the cited art.

Claims 1633 and 1672 describe combinations of features including: "wherein the produced mixture comprises ammonia and wherein the ammonia is used produce fertilizer." At least these features of claims 1633 and 1672, in combination with the other features of the claims, do not appear to be taught or suggested by the cited art.

J. The Claims Are Not Obvious Over Tsai In View of Gregoli Pursuant To 35 U.S.C. § 103(a)

The Examiner rejected claims 1637-1640 and 1676-1679 under 35 U.S.C. 103(a) as obvious over Tsai in view of U.S. Patent No. 6,016,867 to Gregoli et al. (hereinafter "Gregoli"). Applicant respectfully disagrees with these rejections.

Claims 1637 and 1676 recite, in part "altering a pressure within the formation to inhibit production of hydrocarbons from the formation having carbon numbers greater than about 25." At least these features of claims 1637 and 1676, in combination with the other features of the claims, do not appear to be taught or suggested by the cited art.

The Examiner states: "It would have been obvious to one of ordinary skill in the art at the time of the invention to have modified the Tsai method to have included altering pressure to inhibit production of hydrocarbons having carbon numbers greater than about 25, as called for in claims 1637 and 1676, in order to improve production." Applicant respectfully disagrees.

Gregoli discloses:

> Heavy hydrocarbons 207 in the reservoir 27 are heated by the hot injected fluids which, in the presence of hydrogen, initiate hydrovisbreaking reactions. These reactions upgrade the quality of the hydrocarbons by converting their higher molecular-weight components into lower molecular-weight components which have less density, lower viscosity, and greater mobility within the reservoir than the unconverted hydrocarbons. The hydrocarbons subjected to hydrovisbreaking reactions and additional virgin hydrocarbons flow into the perforations 203 of the casing 202 of the production-well borehole 201, propelled by the pressure of the injected fluids. (Gregoli, column 12, lines 35-46)

Gregoli does not appear to teach or suggest at least the feature of altering a pressure within the formation to inhibit production of hydrocarbons from the formation having carbon numbers greater than about 25. Applicant respectfully submits that the Examiner's rejection of the features of claims 1637 and 1676, in combination with the features of independent claims 1608 and 1647, respectively, as obvious matters of choice or design may rely upon personal knowledge of the Examiner and therefore Applicant believes MPEP 2144.03 will apply. Pursuant to MPEP 2144.03, Applicant respectfully requests the Examiner to provide support for his assertion either by an affidavit or by references brought to the Applicant's attention. Otherwise, Applicant requests this rejection be removed. *See, e.g.*, MPEP 2143.01.

Claims 1638 and 1677 recite, in part: "controlling formation conditions by recirculating a portion of hydrogen from the mixture into the formation." At least these features of claims 1638 and 1677, in combination with the other features of the claims, do not appear to be taught or suggested by the cited art.

Claims 1639 and 1678 recite, in part: "providing hydrogen (H_2) to the heated part of the formation to hydrogenate hydrocarbons within the part of the formation; and heating a portion of the part of the formation with heat from hydrogenation." At least these features of claims 1639 and 1678, in combination with the other features of the claims, do not appear to be taught or suggested by the cited art.

Claims 1640 and 1679 recite, in part: "producing hydrogen and condensable hydrocarbons from the formation; and hydrogenating a portion of the produced condensable hydrocarbons with at least a portion of the produced hydrogen." At least these features of claims 1640 and 1679, in combination with the other features of the claims, do not appear to be taught or suggested by the cited art.

The Examiner states "It would have been obvious to one of ordinary skill in the art at the time of the invention to have modified the Tsai method to have included recirculating hydrogen as called for in claims 1638; providing hydrogen as called for in claims 1639; and hydrogenating as called for in claims 1640; in order to reduce the heavy hydrocarbons and to improve production." Applicant respectfully disagrees.

Gregoli discloses:

> Of interest is to inject hot gases into the reservoir 27 by way of the injection-well borehole 21 and continuously recover hydrocarbon products from the production-well borehole 201. Referring again to FIG. 1, three fluids under pressure are coupled to the wellhead control system 31: a source of reducing gas by line 81, a source of oxidizing-fluid by line 91, and a source of cooling-fluid by line 101. Through injection tubing strings 205, the three fluids are coupled to the downhole combustion unit 206. The fuel is oxidized by the oxidizing fluid in the combustion unit 206, which is cooled by the cooling fluid. The products of oxidation and the cooling fluid 209 along with any un-oxidized fuel 210, all of which are heated by the exothermic oxidizing reaction, are injected into the horizontal fracture 204 in the reservoir 27 through the perforations 200 in the casing 29. Heavy hydrocarbons 207 in the reservoir 27 are heated by the hot injected fluids which, in the presence of hydrogen, initiate hydrovisbreaking reactions. These reactions upgrade the quality of the hydrocarbons by converting their higher molecular-weight components into lower molecular-weight components which have less density, lower viscosity, and greater mobility within the reservoir than the unconverted hydrocarbons. (Gregoli, column 12, lines 20-42).

Thus, Gregoli appears to teach or suggest heating fluids with heat from an oxidizing reaction and injecting the hot fluids into a reservoir to initiate hydrovisbreaking in the presence

of hydrogen. Gregoli does not appear to teach or suggest at least the above-cited features of claims 1638-1640 and 1676-1679, in combination with the features of the claims.

Applicant requests removal of the obviousness rejection of claims 1637-1640 and 1676-1679.

K. The Claims Are Not Obvious Over Tsai In View of Van Meurs Pursuant To 35 U.S.C. § 103(a)

The Examiner rejected claims 1644-1645, 1683-1684, 1919-1920, and 1958-1959 under 35 U.S.C. 103(a) as obvious over Tsai in view of U.S. Patent No. 4,886,118 to Van Meurs et al. (hereinafter "Van Meurs"). Applicant respectfully disagrees with these rejections.

The Examiner states: "It would have been obvious to one of ordinary skill in the art at the time of the invention to have modified the Tsai method to have included at least about 7 heat sources disposed in the formation for each production well, as called for in claims 1644, 1683, 5396, and 5397 in order to improve production." The Examiner further states: "It would have been obvious to one of ordinary skill in the art at the time of the invention to have modified the Tsai method to have included at least about 20 heat sources for each production well as called for in claims 1645, 1684 in order to improve production." Applicant respectfully disagrees.

Applicant submits that the selection of the number of heater wells provided for a production well is not an obvious matter of choice or design but, rather, may be based upon non-obvious choices such as desired product composition, desired production rates, desired heating rates, etc. Claims 1644 and 1683 describe a combination of features including: "producing a mixture in a production well, and wherein at least about 7 heaters are disposed in the formation for each production well." Claims 5396 and 5397 describe a combination of features including: "wherein at least about 20 heaters are disposed in the formation for each production well." At least the above quoted features of claims 1645, 1683, 5396 and 5397, in combination with the other features of the claims, do not appear to be taught, suggested, or obvious in light of the cited

art.

Claims 1645 and 1684 recite, in part "further comprising providing heat from three or more heaters to at least a portion of the formation, wherein three or more of the heaters are located in the formation in a unit of heaters, and wherein the unit of heaters comprises a triangular pattern." At least these features of claims 1645 and 1684, in combination with the other features of the claims, do not appear to be taught or suggested by the cited art.

L. The Claims Are Not Obvious Over Tsai In View of Van Meurs and Salomonsson Pursuant To 35 U.S.C. § 103(a)

The Examiner rejected claims 1646 and 1685 under 35 U.S.C. 103(a) as obvious over Tsai in view of Van Meurs et al. and further in view of U.S. Patent No. 2,914,309 to Salomonsson (hereinafter "Salomonsson"). Applicant respectfully disagrees with this rejection.

Claims 1646 and 1685 recite, in part "providing heat from three or more heaters to at least a portion of the formation, wherein three or more of the heaters are located in the formation in a unit of heaters, wherein the unit of heaters comprises a triangular pattern, and wherein a plurality of the units are repeated over an area of the formation to form a repetitive pattern of units." At least these features of claims 1646 and 1685, in combination with the other features of the claims, do not appear to be taught or suggested by the cited art.

M. The New Claims Are Not Anticipated or Obvious in view of the Cited Art

New claim 5400 describes a combination of features including: "allowing the heat to transfer from one or more of the heaters to a selected section of the formation; wherein at least some hydrocarbons within the selected section have an initial atomic hydrogen weight percentage of greater than about 4.0 %." Applicant submits that the cited art does not appear to teach or suggest the combination of features in claim 5400 and the claims dependent thereon.

N. Conclusion

Applicant submits that all claims are in condition for allowance. Favorable reconsideration is respectfully requested.

A Fee Authorization is enclosed to cover fees for additional claims and for an information disclosure statement filed concurrent with this response. If an extension of time is required, Applicant hereby requests the appropriate extension of time. If any additional fees are required or if any fees have been overpaid, please appropriately charge or credit those fees to Conley, Rose & Tayon, P.C. Deposit Account Number 50-1505/5659-01800/EBM.

Respectfully submitted,

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Date: 10/28/02

Marked-Up Copy Of The Amendments Submitted In Response To The Office Action Mailed On July 26, 2002

In The Specification:

On page 38, please delete the paragraph beginning on line 14, and substitute therefor:

As used herein, "a method of treating a hydrocarbon containing formation" may be used interchangeably with "an in situ conversion process for hydrocarbons." "Hydrocarbons" are generally defined as ~~organic material that contains~~ molecules formed primarily by carbon and hydrogen atoms. ~~carbon and hydrogen in their molecular structures.~~ Hydrocarbons may also include other elements, such as, but not limited to, halogens, metallic elements, nitrogen, oxygen, and/or sulfur. Hydrocarbons may be, but are not limited to, kerogen, bitumen, pyrobitumen, and oils. Hydrocarbons may be located within or adjacent to mineral matrices within the earth. Matrices may include, but are not limited to, sedimentary rock, sands, silicilytes, carbonates, diatomites, and other porous media.

On page 64, please delete the paragraph beginning on line 11, and substitute therefor:

As shown in FIG. 3, in addition to heat sources 100, one or more production wells ~~102~~ 104 will typically be disposed within the portion of the hydrocarbon containing formation. Formation fluids may be produced through production well 104. ~~Production well 102 may be configured such that a mixture that may include formation fluids may be produced through the production well.~~ Production well ~~102~~104 may also include a heat source. In this manner, the formation fluids may be maintained at a selected temperature throughout production, thereby allowing more or all of the formation fluids to be produced as vapors. Therefore high temperature pumping of liquids from the production well may be reduced or substantially eliminated, which in turn decreases production

costs. Providing heating at or through the production well tends to: (1) ~~prevent~~ inhibit condensation and/or refluxing of production fluid when such production fluid is moving in the production well proximate to the overburden, (2) increase heat input into the formation, and/or (3) increase formation permeability at or proximate the production well.

In The Claims:

1608. (amended) A method of treating a hydrocarbon containing formation in situ, comprising:

providing heat from one or more ~~heat sources~~ heaters to at least a portion of the formation;

allowing the heat to transfer from ~~the~~ one or more ~~heat sources~~ of the heaters to a ~~selected section~~part of the formation;

wherein the ~~selected section~~part of the formation has been selected for heating using an atomic hydrogen weight percentage of at least a portion of hydrocarbons in the ~~selected section~~part of the formation, and wherein at least the portion of the hydrocarbons in the ~~selected section~~part of the formation comprises an atomic hydrogen weight percentage, when measured on a dry, ash-free basis, of greater than about 4.0 %; and

producing a mixture from the formation.

1609. (amended) The method of claim 1608, wherein ~~the~~ one or more ~~heat sources~~ of the heaters comprise at least two ~~heat sources~~heaters, and wherein superposition of heat from at least the two ~~heat sources~~heaters pyrolyzes at least some hydrocarbons within the ~~selected section~~part of the formation.

1610. (amended) The method of claim 1608, further comprising maintaining a temperature within the ~~selected section~~part of the formation within a pyrolysis temperature range of about 270 °C to about 400 °C.

1611. (amended) The method of claim 1608, wherein at least one of the one or more ~~heat sources~~heaters comprises an electrical heaters.

1612. (amended) The method of claim 1608, wherein at least one of the one or more ~~heat sources~~heaters comprises a surface burners.

1613. (amended) The method of claim 1608, wherein at least one of the one or more ~~heat sources~~ heaters comprises a flameless distributed combustors.

1614. (amended) The method of claim 1608, wherein at least one of the one or more ~~heat sources~~heaters comprises a natural distributed combustors.

1615. (amended) The method of claim 1608, further comprising controlling a pressure and a temperature within at least a majority of the ~~selected section~~ part of the formation, wherein the pressure is controlled as a function of temperature, or the temperature is controlled as a function of pressure.

1616. (amended) The method of claim 1608, further comprising pyrolyzing hydrocarbons within the part of the formation and controlling the heat such that an average heating rate of the ~~selected section~~part of the formation is less than about 1 °C per day during pyrolysis.

1617. (amended) The method of claim 1608, wherein providing heat from ~~the~~ one or more ~~heat sources~~of the heaters to at least the portion of formation comprises:

heating a selected volume (V) of the hydrocarbon containing formation from ~~the~~ one or more ~~heat sources~~of the heaters, wherein the formation has an average heat capacity (Cv), and wherein the heating pyrolyzes at least some hydrocarbons within the selected volume of the formation; and

wherein heating energy/day (*Pwr*) provided to the selected volume is equal to or less than $h*V*C_v*\rho_B$, wherein ρ_B is formation bulk density, and wherein an average heating rate (h) of the selected volume is about 10 °C/day. ~~wherein heating energy/day~~

~~provided to the volume is equal to or less than Pwr, wherein Pwr is calculated by the equation:~~

~~$Pwr = h*V*Cv*\rho B$~~

~~wherein Pwr is the heating energy/day, h is an average heating rate of the formation, ρB is formation bulk density, and wherein the heating rate is less than about 10 °C/day.~~

1619. (amended) The method of claim 1608, wherein providing heat from ~~the~~ one or more ~~heat sources~~of the heaters comprises heating the ~~selected section~~part of the formation such that a thermal conductivity of at least a portion of the ~~selected section~~part of the formation is greater than about 0.5 W/(m °C).

1631. (amended) The method of claim 1608, wherein the produced mixture comprises a non-condensable component that does not condense at 25° C and one atmosphere absolute pressure, wherein the non-condensable component comprises hydrogen, wherein the hydrogen is greater than about 10 % by volume of the non-condensable component, and wherein the hydrogen is less than about 80 % by volume of the non-condensable component.

1634. (amended) The method of claim 1608, further comprising controlling a pressure within at least a majority of the ~~selected section~~ part of the formation, wherein the controlled pressure is at least about 2.0 bar absolute.

1639. (amended) The method of claim 1608, further comprising:

providing hydrogen (H_2) to the heated ~~section~~ part of the formation to hydrogenate hydrocarbons within the ~~section~~part of the formation; and

heating a portion of the ~~section~~ part of the formation with heat from hydrogenation.

1641. (amended) The method of claim 1608, wherein allowing the heat to transfer comprises increasing a permeability of a majority of the ~~selected section~~part of the formation to greater than about 100 millidarcy.

1642. (amended) The method of claim 1608, wherein allowing the heat to transfer comprises ~~substantially uniformly~~ increasing a permeability of a majority of the ~~selected section~~part of the formation such that the permeability of the majority of the part of the formation is substantially uniform.

1644. (amended) The method of claim 1608, wherein producing the mixture comprises producing the mixture in a production well, and wherein at least about 7 ~~heat sources~~heaters are disposed in the formation for each production well.

1645. (amended) The method of claim 1608, further comprising providing heat from three or more ~~heat sources~~heaters to at least a portion of the formation, wherein three or more of the ~~heat sources~~heaters are located in the formation in a unit of ~~heat sources~~heaters, and wherein the unit of ~~heat sources~~heaters comprises a triangular pattern.

1646. (amended) The method of claim 1608, further comprising providing heat from three or more ~~heat sources~~heaters to at least a portion of the formation, wherein three or more of the ~~heat sources~~heaters are located in the formation in a unit of ~~heat sources~~heaters, wherein the unit of ~~heat sources~~heaters comprises a triangular pattern, and wherein a plurality of the units are repeated over an area of the formation to form a repetitive pattern of units.

1647. (amended) A method of treating a hydrocarbon containing formation in situ, comprising:

providing heat from one or more ~~heat sources~~heaters to at least a portion of the formation;

allowing the heat to transfer from ~~the~~ one or more ~~heat sources~~of the heaters to a ~~selected section~~ part of the formation;

wherein at least some hydrocarbons within the ~~selected section~~part of the formation have an initial atomic hydrogen weight percentage of greater than about 4.0 %; and

producing a mixture from the formation.

1648. (amended) The method of claim 1647, wherein ~~the~~ one or more ~~heat sources~~of the heaters comprise at least two ~~heat sources~~heaters, and wherein controlled superposition of heat from at least the two ~~heat sources~~heaters pyrolyzes at least some hydrocarbons within the ~~selected section~~part of the formation of the formation.

1649. (amended) The method of claim 1647, further comprising maintaining a temperature within the ~~selected section~~part of the formation within a pyrolysis temperature range of about 270 °C to about 400 °C.

1650. (amended) The method of claim 1647, wherein at least one of the one or more ~~heat sources~~heaters comprises an electrical heaters.

1651. (amended) The method of claim 1647, wherein at least one of the one or more ~~heat sources~~heaters comprises a surface burners.

1652. (amended) The method of claim 1647, wherein at least one of the one or more ~~heat sources~~heaters comprises a flameless distributed combustors.

1653. (amended) The method of claim 1647, wherein at least one of the one or more ~~heat sources~~heaters comprises a natural distributed combustors.

1654. (amended) The method of claim 1647, further comprising controlling a pressure and a temperature within at least a majority of the ~~selected section~~part of the formation of

the formation, wherein the pressure is controlled as a function of temperature, or the temperature is controlled as a function of pressure.

1655. (amended) The method of claim 1647, further comprising pyrolyzing hydrocarbons within the part of the formation, and controlling the heat such that an average heating rate of the part of the formation ~~selected section~~ is less than about 1 °C per day during pyrolysis.

1656. (amended) The method of claim 1647, wherein providing heat from ~~the~~ one or more ~~heat sources~~of the heaters to at least the portion of formation comprises:

heating a selected volume (V) of the hydrocarbon containing formation from ~~the~~ one or more ~~heat sources~~of the heaters, wherein the formation has an average heat capacity (Cv), and wherein the heating pyrolyzes at least some hydrocarbons within the selected volume of the formation; and

wherein heating energy/day (*Pwr*) provided to the selected volume is equal to or less than $h*V*C_v*\rho_B$, wherein ρ_B is formation bulk density, and wherein an average heating rate (h) of the selected volume is about 10 °C/day.~~wherein heating energy/day provided to the volume is equal to or less than Pwr, wherein Pwr is calculated by the equation:~~

~~Pwr = h*V*Cv*ρB~~

~~wherein Pwr is the heating energy/day, h is an average heating rate of the formation, ρB is formation bulk density, and wherein the heating rate is less than about 10 °C/day.~~

1658. (amended) The method of claim 1647, wherein providing heat from ~~the~~ one or more ~~heat sources~~of the heaters comprises heating the ~~selected section~~part of the formation such that a thermal conductivity of at least a portion of the ~~selected section~~part of the formation is greater than about 0.5 W/(m °C).

1670. (amended) The method of claim 1647, wherein the produced mixture comprises a non-condensable component that does not condense at 25° C and one atmosphere

absolute pressure, wherein the non-condensable component comprises hydrogen, wherein the hydrogen is greater than about 10 % by volume of the non-condensable component, and wherein the hydrogen is less than about 80 % by volume of the non-condensable component.

1673. (amended) The method of claim 1647, further comprising controlling a pressure within at least a majority of the ~~selected section~~part of the formation of the formation, wherein the controlled pressure is at least about 2.0 bar absolute.

1678. (amended) The method of claim 1647, further comprising:

providing hydrogen (H_2) to the heated ~~section~~ part of the formation to hydrogenate hydrocarbons within the ~~section~~part of the formation; and

heating a portion of the ~~section~~ part of the formation with heat from hydrogenation.

1680. (amended) The method of claim 1647, wherein allowing the heat to transfer comprises increasing a permeability of a majority of the ~~selected section~~part of the formation to greater than about 100 millidarcy.

1681. (amended) The method of claim 1647, wherein allowing the heat to transfer comprises ~~substantially uniformly~~ increasing a permeability of a majority of the ~~selected section~~part of the formation such that the permeability of the majority of the part of the formation is substantially uniform.

1683. (amended) The method of claim 1647, wherein producing the mixture comprises producing the mixture in a production well, and wherein at least about 7 ~~heat sources~~heaters are disposed in the formation for each production well.

1684. (amended) The method of claim 1647, further comprising providing heat from three or more ~~heat sources~~heaters to at least a portion of the formation, wherein three or more of the ~~heat sources~~heaters are located in the formation in a unit of ~~heat~~

~~sources~~heaters, and wherein the unit of ~~heat sources~~heaters comprises a triangular pattern.

1685. (amended) The method of claim 1647, further comprising providing heat from three or more ~~heat sources~~heaters to at least a portion of the formation, wherein three or more of the ~~heat sources~~heaters are located in the formation in a unit of ~~heat sources~~heaters, wherein the unit of ~~heat sources~~heaters comprises a triangular pattern, and wherein a plurality of the units are repeated over an area of the formation to form a repetitive pattern of units.

5396. (amended) The method of claim 1644, wherein at least about 20 ~~heat sources~~heaters are disposed in the formation for each production well.

5397. (amended) The method of claim 1683, wherein at least about 20 ~~heat sources~~heaters are disposed in the formation for each production well.